CODE SPACE SHARING AMONG
MULTIPLE MODES OF OPERATION

Related Applications

5   Related subject matter is disclosed in the following application filed concurrently herewith and assigned to the same assignee hereof: U.S. Patent Application entitled "Dynamic Reassignment Of Code Space Among Multiple Modes Of Operation", Serial No. ___.

Background of the Invention

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1.   Field of the Invention

The present invention relates to communications; more specifically, wireless communications.

15   **2.   Description of the Related Art**

In some wireless communication systems, channels are distinguished using orthogonal codes such as Walsh codes that are assigned from a collection of codes that constitute a code space. Typically each user is given full time access to a subspace of the code space such as one or more Walsh codes. This type of use of the code space is inefficient in multiple mode

20   operations such as in systems supporting both voice and data users.

Summary of the Invention

The present invention divides the code space associated with the communication system into two subspaces where each subspace is assigned to a different mode of operation. In one

25   mode, such as a voice mode, each user is given full time access to a portion of the subspace associated with that mode of operation until the communication session is ended by, for example, a handoff, a dropped call or an end of call. In a second mode, such as a data mode, each user uses the entire subspace associated with that mode on a time shared basis.

30   **Brief Description of the Drawings**

FIG. 1 illustrates Walsh matrices;

FIG. 2 illustrates a Walsh matrix of order 4;

FIG. 3 illustrates the derivation paths for different Walsh spaces;

FIG. 4 illustrates the relationship between portions of a 128 Walsh code code space; and

FIG. 5 illustrates the distribution of code space between two modes of operation.

Detailed Description

5   Walsh codes have the distinctive property that higher Walsh space codes can be derived

from the lower Walsh space codes.

FIG. 3 illustrates a Walsh matrix of order 1 and order 2, and a Walsh matrix of order 2n.

The rows of the matrix are the Walsh codes composing the Walsh space. The relationship

between a Walsh matrix of order n and order 2n is a recursive relationship and is used to easily

10   produce larger order Walsh matrices. For example, in creating a Walsh matrix of order 4, the

Walsh matrix of order 2 is inserted into the upper left hand corner, the upper right hand corner,

and the lower left hand corner of the Walsh matrix of order 4. The bar version of the Walsh

matrix of order 2 is inserted into the lower right hand corner of the Walsh matrix of order 4. The

bar version of the matrix is formed by taking the logical inverse of each element of the matrix.

15   FIG. 2 illustrates a Walsh matrix of order 4.

Orthogonality across codes from different spaces is possible as long as two codes that are

in the same derivation path are not selected simultaneously. Consider FIG. 3. Here, a code from

the Walsh space of Walsh-16 is used to derive two codes from the Walsh space of Walsh-32.

Likewise, each Walsh code from the Walsh-32 space is used to create two codes from the Walsh-

20   64 space and so on. In the figure $W_{x,y}$ represents the y'th Walsh code form the Walsh space of

Walsh-x. Now, from the figure, one can see that, for example, while $W_{32,1}$ and $W_{64,3}$ are

orthogonal, $W_{32,1}$ and $W_{64,2}$ are not.

When assigning code space to mode one users, such as voice users, and assigning other

code space to mode two users, such as data users, it is desirable to divide the codes in large

25   blocks that originate from a lower order Walsh code such as a 16 symbol code. By assigning the

subspaces in groups originating from lower order Walsh codes, a receiver's design is simplified

by requiring fewer decoding paths to receive transmissions. For example, in a system using 128

symbol Walsh codes, it is desirable to assign the codes to the subspaces in groups of 8

consecutive codes so that a receiver would only need 16 decoding paths to receive transmissions.

30   In reference to FIG. 4, an initial set of subspace assignments may be with $W_{128,1}$ through

$W_{128,8}$ being assigned to mode 1 operations while the remaining Walsh codes are assigned to the

mode 2 (Walsh codes $W_{128,9}$ through $W_{128,128}$). It should be noted that the code spaces have been

divided into subspaces originating from 16 symbol Walsh codes which allows a receiver to use 16 decoding paths to receive transmissions. In the mode 1 subspace one or more codes are assigned to each user on a full time basis or until communications are complete with that user. In the mode 2 subspace, all of the codes are assigned to a single user on a time shared or time

5   multiplexed basis. For example, each of n users may use the entire mode 2 code subspace for 1/n of the time.

It is also possible to distribute the codes among the mode 1 and mode 2 subspaces on a dynamic basis. For example, if one code in the mode 1 subspace is not being used, it may be assigned to the mode 2 subspace; however, this is subject to the code from the mode 1 subspace being orthogonal to all of the other codes in the mode 2 subspace. If more codes in the mode 1

10   subspace are unused, they may be assigned to the mode 2 subspace as well, but once again subject to the codes from the mode 1 subspace being orthogonal to all of the other codes presently in use in the mode 2 subspace. Similarly, unused codes in the mode 2 subspace may be assigned to the mode 1 subspace subject to the codes from the mode 2 subspace being orthogonal

15   to all of the codes presently in use in the mode 1 subspace. Information regarding the current set of code assignments may be transmitted by a base station to users as well as other base stations using communication channels such as control channels or paging channels.

FIG. 5 illustrates the distribution of codes between the mode 1 and mode2 subspaces. Portion 10 may be assigned to the mode 1 subspace while portion 20 is assigned to the mode 2

20   subspace. It should be noted that a guardband 30 is provided where codes are not assigned to either subspace. This guardband allows the mode 1 or mode 2 subspaces to expand without immediately removing a code from the other subspace. After some of the codes in the guardband are assigned to one of the subspaces, the guardband is expanded to its original size by taking codes from either subspace as they become available. Additionally, each of the code spaces may

25   be assigned a minimum number of codes indicated by bands 40. These bands guarantee that each of the mode 1 and mode 2 subspaces always have a minimum number of codes for operation.